What is claimed is:

1. A method for growing a graphene film, comprising:

disposing a carbonizing catalyst having a surface in a chemical-vapor-deposition (CVD) reaction chamber having a pressure in a range from 133 mPa (1 mtorr) to 101 Pa (760 torr), and a temperature in a range from 200°C to 1,200°C;

flowing a gaseous carbon source having carbon atoms, and a weak oxidizing vapor over the surface of the carbonizing catalyst for a time in the range from 1 minute to 1 hour, thereby causing the carbon atoms from the carbon source to deposit in a crystalized carbon-atom arrangement on the surface of the carbonizing catalyst; and

cooling the carbonizing catalyst at a cooling rate from 0.1 degree Celsius per minute to 10 degree Celsius per minute and the crystalized carbon-atom arrangement to form a multilayer graphene film on the surface of the carbonizing catalyst;

wherein the gaseous carbon source is supplied at a flow rate from 0.5 standard cubic centimeters per minute (“sccm”) to 50 sccm; and

optionally wherein said method further comprises performing a chemical-doping step to chemically dope the multilayer graphene film,

characterized in that the weak oxidizing vapor is water or ethanol, provided in an amount of 1% to 10% by volume in an inert gas.

2. The method of claim 1, further comprising separating the multilayer graphene film from the carbonizing catalyst.

3. The method of claim 2, wherein said separating comprises:

forming a protective layer, comprising, for example PMMA, over the multilayer graphene film;

etching away the carbonizing catalyst; and

removing the protective layer from the multilayer graphene film.

4. The method of claim 1, wherein the carbonizing catalyst is disposed in the CVD reaction chamber as a film having a thickness in a range from 300 nm to 1,000 nm or 0.01 mm to 5 mm.

5. The method of claim 1, wherein the carbonizing catalyst is formed from at least one metal selected from the following group of metals: Ni, Cu, Co, Fe, Rh, Pt, Au, Ru and Mo.

6. The method of claim 1, wherein the gaseous carbon source includes at least one gas selected from the following group of gases: carbon monoxide, methane, ethane, ethylene, ethanol, acetylene, propane, propylene, butane, butadiene, pentane, pentene, cyclopentadiene, hexane, cyclohexane, benzene and toluene.

7. The method of claim 1, further comprising flowing hydrogen through the reaction chamber to reduce the carbonizing catalyst.

8. The method of claim 1, wherein the surface of the carbonizing catalyst includes amorphous carbon, and further comprising oxidizing the amorphous carbon while avoiding substantially disrupting the crystalized carbon-atom arrangement on the surface of the carbonizing catalyst.